Static Analysis Of Passive Inclined Disc Opener

Mr. M.S.Dharamkar[1], Prof. D.S.Galhe[2]

[1] *Student, Department Of Mechanical Engineering, Jayhind College Of Engineering Kuran, Maharashtra, India*
[2] *Professor, Department Of Mechanical Engineering, Jayhind College Of Engineering Kuran, Maharashtra, India*

ABSTRACT

Inclined disc opener are used in order to open the soil in a farm during the seed sowing operation. Disc openers are used where uniform seed depth is required. It is also observe that draft force required for furrow opening is also reduced as compared to conventional type of furrow opener. Disc is continuously runs in a soil and when it is stop it takes a load of frame. During turning of tractor it takes a maximum load upto 150 Kgs with some depth. Thus the static analysis of such a type of disc is important. In this paper analysis of disc is carried out by using an ANSYS software. The analysis is based upon some fixed design consideration such as design parameters diameter of disc, thickness of disc, construction, etc. Disc opener also helps in minimum soil opening in order to conserve the moisture in the soil thus it helps in to increase the germination rate of seed. Hexahedral meshing is used for the analysis of disc in order to achieve finest results.

Keyword : - *Static, draft force, meshing, germination, etc.*

1. INTRODUCTION

Disc plays an important role in opening a furrow. It takes a different types of load during its operation. During the sowing process in agriculture field it is observe that the seed depth is non uniform. Result of which there is non uniform growth of plants. It may possible that one of the plant contains 100 numbers of fruits and second should have only 50 numbers of fruits. During the harvesting process this uneven growth of plants as well as uneven fruits of plants does not take into consideration. Thus result of which there is reduction in overall crop yield of farmer. It may possible that this uneven growth of plant is due to the germination of seed, quality of seed, etc. The one of the reason for this non uniform growth of plants is use of conventional type of tines. The Self Suspended Dispensing Coulter comprises consist of two disc which are inclined to each other and are symmetrically fitted. The function of these two disc is to open the furrow at required width in order to dispense the seed and fertilizer. The compression spring is used to give the load on the disc. Two passive double inclined disc are used for covering of seed and fertilizer in order to retain moisture in soil and increases the germination rate. It is also provided with `spring load for uniform covering of seed. The slight pressure on the seed results in firm contact of soil molecules with the seed which increases the germination rate as well as fast initial growth of plant. The draft force required for tractor is comparatively reduced as compared to the conventional type of tine and hence required tractor power is also reduced. Agricultural conservation systems are growing fastly in the world as well as India. Success of using and extending conservation tillage systems in particular, is depended on the performance of direct drilling machines. The suitable machine has to place seed in a proper depth at different field conditions including not plowing, high residue contents and sticky. Moreover the performance of such machine in those conditions is affected by its furrow openers. In this research different furrow openers including common double disc types were investigated with the goal of increasing performance of planting machines in the conservation systems. The treatments were : 1. Double disc type both with angles 2. Double disc type one vertical and one with angle. Double disc coulter type openers usually consist of two plain, flat disc coulters arranged so that the lower leading edges of the discs touch to cut and displace soil. As the discs roll forward, they cut residue and soil, and displace soil downwards and outwards to form a 'V'-shaped furrow. The seed delivery tube is fully enclosed by the discs and enables seed to be deposited into the furrow at a position slightly ahead of the point where the trailing edges of the discs leave the soil. In such s way disc have its vital role in opening the furrow and it work as one of the main component of sowing system. In static

analysis total deformation, equivalent stress, maximum principal stress, maximum shear stress, equivalent elastic strain, maximum principal elastic strain, maximum shear elastic strain is carried out.

1.1 Disc furrow opener

Disc coulters have different parameters that will affect their performance and also their interaction with soil. Disc diameter, disc thickness, edge angle, disc angle, tilt angle and also depth of the cut are the parameters that can change the forces acting on the disc when cutting through the soil. Edge angle is the slope of the edge of the disc that defines its sharpness. Although it seems to be a negligible parameter among other parameters of the soil, it plays an important role in residue cutting ability of the disc. Also it can change the draft force required to pull the disc. Disc angle is the angle of rotation of the disc around vertical axis. It is the angle that horizontal axis of the disc makes with the direction of motion.

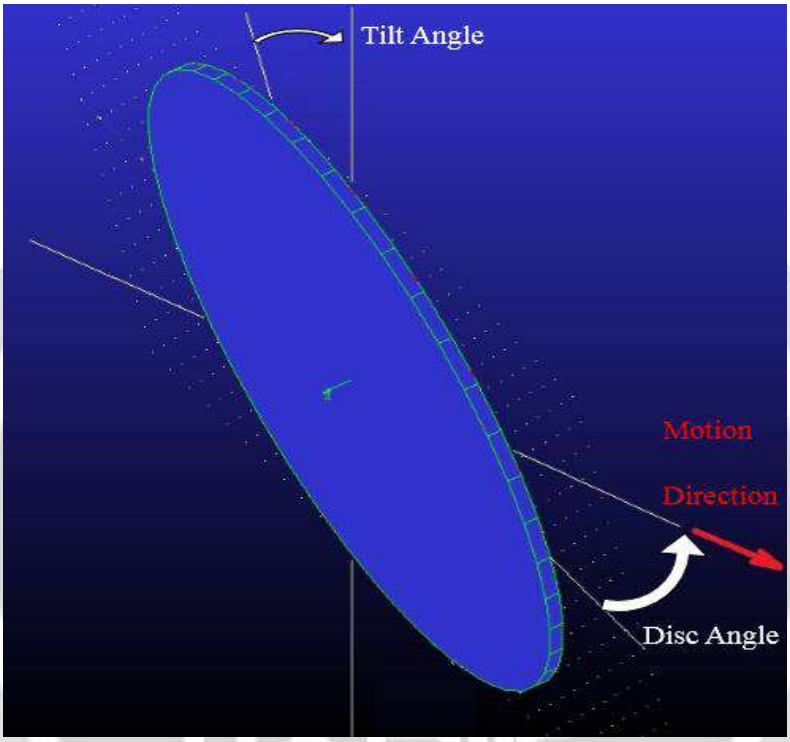

Fig. 1 : Schematic diagram of a disc coulter, showing disc angle (ɣ) and tilt angle (β)

And the tilt angle is the angle of the disc with the vertical plane, or the angle created by rotation of the disc around disc's horizontal axis. Having a disc angle of greater than zero, in a planter that uses disc coulter, is inevitable. Because the disc should open a furrow, wide enough that a seed can fit. But the tilt angle is optional. We call it a compound angle when a disc coulter is orientated using both disc and tilt angles. The effect of these angles and their combination had to be studied, to find the best combination that result in minimum draft force (the horizontal reaction force to the disc motion). Starting with the soil engagement tool, double discs with compound angle and installed at a staggered position. The disc angle and tilt angles of these discs are ɣ=5º and β=7º, respectively. Diameter of disc selected as D= 305 mm.

2. STATIC ANALYSIS OF DISC

Disc furrow opener is one of the important part which continuously run in a soil. The material used for this disc is mild steel. The disc is mounted on the shaft with a bearing housing. The disc is having a total 5 holes. One hole is provided at the centre where as other four holes are provided at pitch circle diameter in order to fasten bearing housing and furrow opening disc by means of nut and bolts. The disc is having diameter of 304 mm with a thickness of 3 mm. Thus at the point where holes are provided there are chances of stress concentration and breaking. Thus

analysis of this component for static as well as dynamic condition is necessary. Fig. 2 shows the ansys model which is imported from the catia.

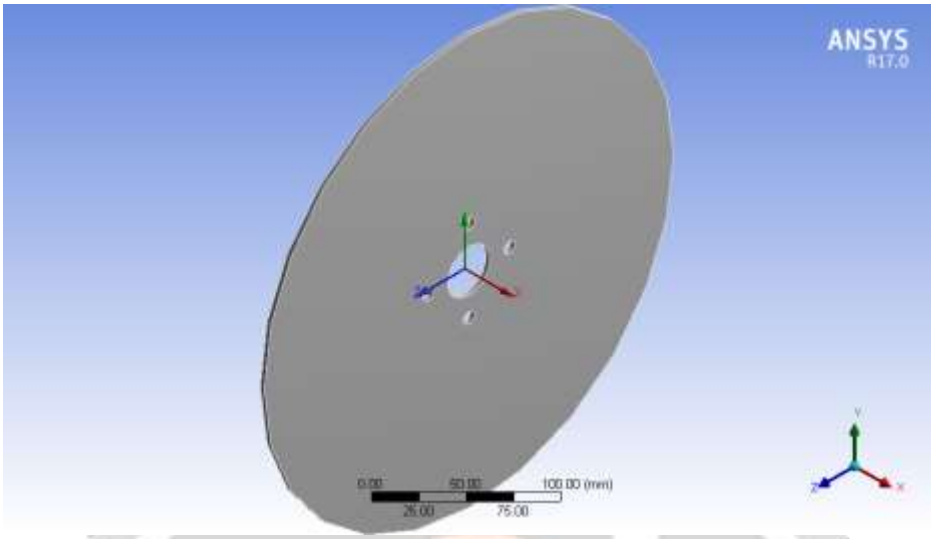

Fig 2 : Ansys model of disc furrow opener

Fig. 3 shows the meshing of disc. The meshing is done in a hexahedral form with 1465 numbers of elements and 3058 numbers of nodes. The boundary box length is provided in X, Y and Z is 3 mm, 304 mm, 304 mm. Meshing size is very important for the better result hence hexahedral form is selected for meshing.

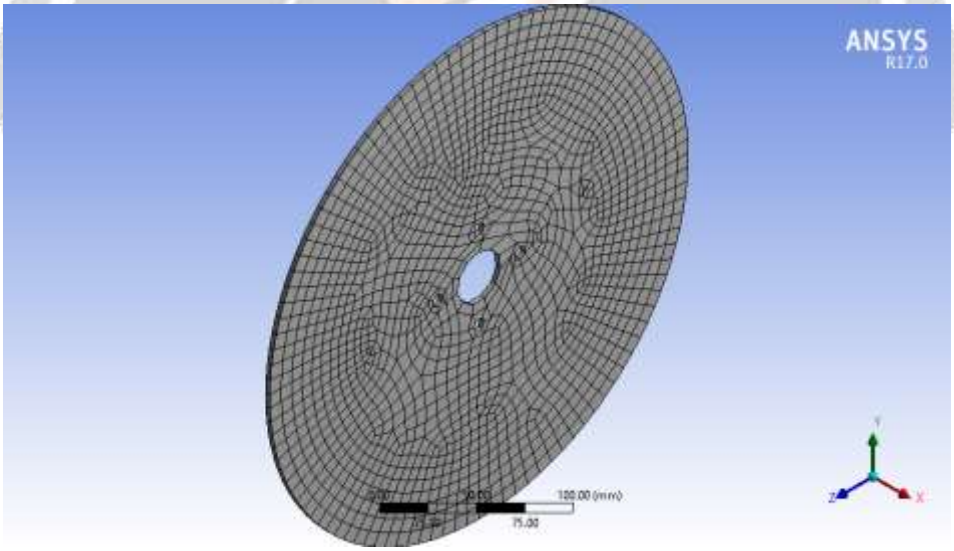

Fig 3: Meshing of disc furrow opener

External loads and boundary conditions are applied to the furrow opener disc as shown in fig. 4. Maximum axial force on a disc calculated in chapter 3 is 1500 N, but for more safer size and by considering very worse condition of soil it is taken 10 times hence the axial force in X direction is taken as 15001 N and moment is 30000 N.

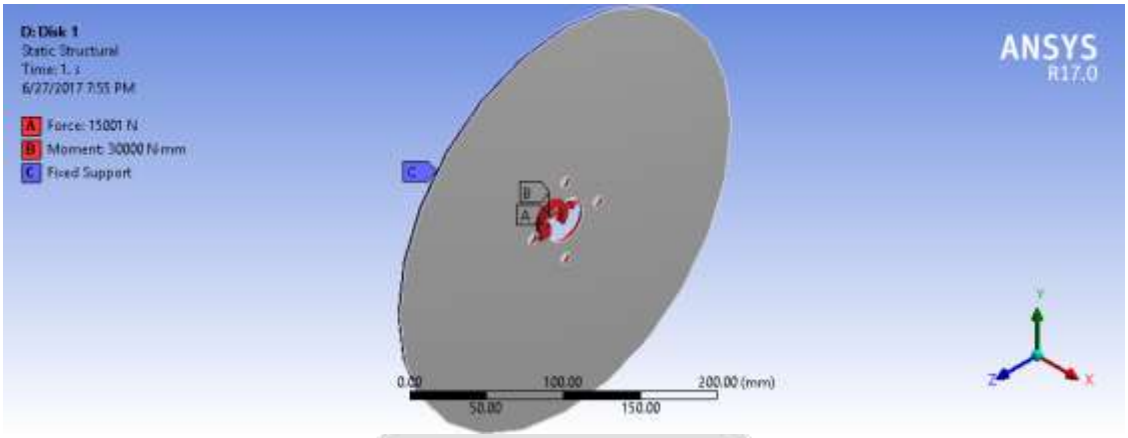

Fig. 4 : External loads and moment

Fig. 5 shows the boundary condition applied at four fixed points. These four holes are provided on pitch circle diameter in order to fasten it with bearing housing and centre hole is provided for shaft of bearing. Thus these four holes are fixed and boundary condition is applied for same.

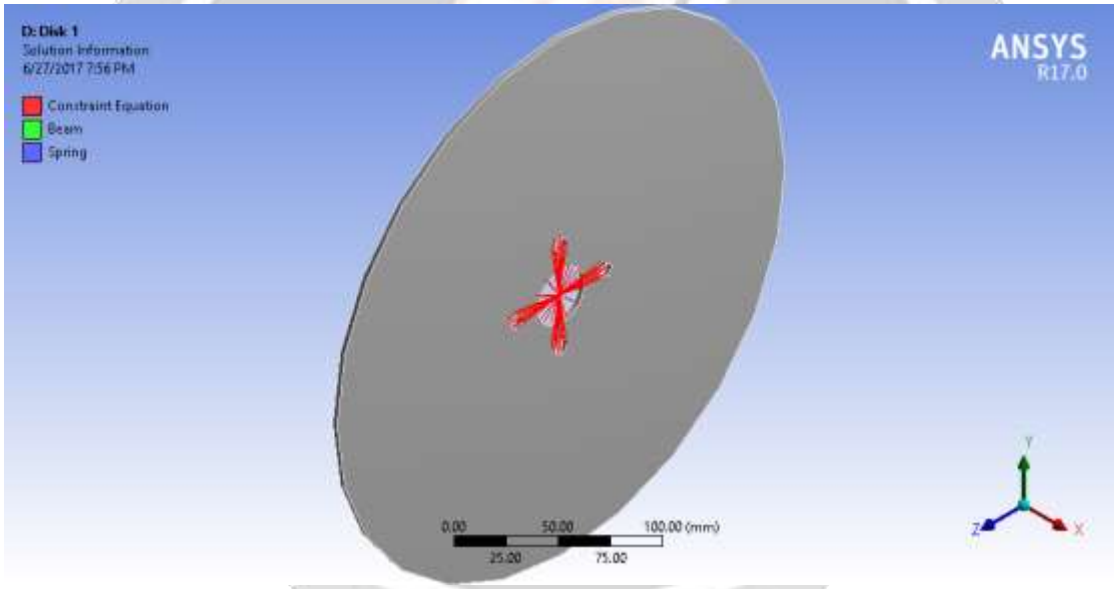

Fig. 5 : Boundary condition

Fig.6 shows the total deformation when the load is applied as 15001 N. It is observed that the minimum deformation is found at the edges of disc and the maximum deformation found on centre hole i.e. in between pitch circle diameter holes and centre hole. Thus it is seen that near the area where holes are provided the deformation is maximum.

Table 1 : Total deformation

Time [s]	Minimum [mm]	Maximum [mm]
1.	0.	1.3185e-002

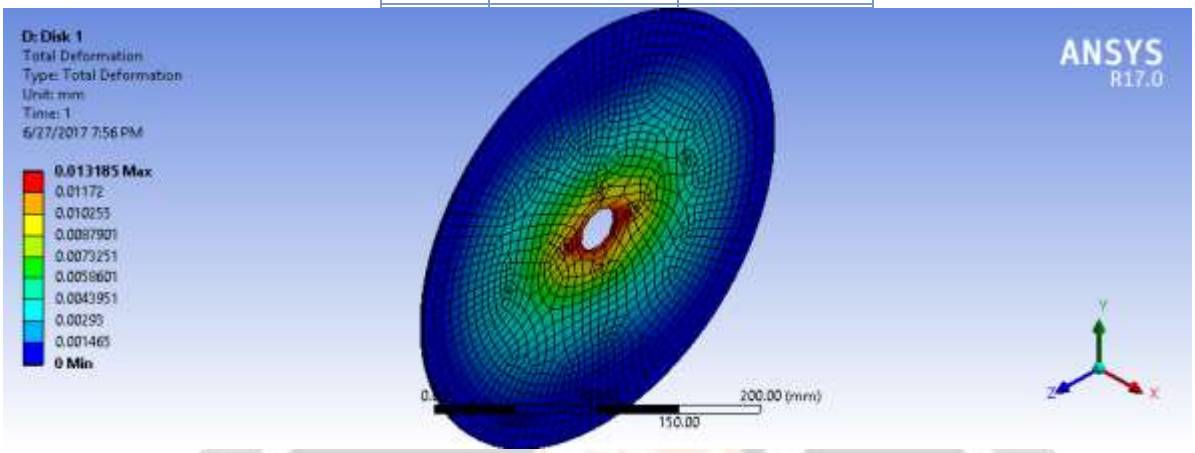

Fig. 6 : Total deformation

Fig. 7 shows the Von Mises stress on a disc furrow opener disc. It is found that maximum stress is occurs at the holes on a pitch circle diameter and it is minimum at the edges of disc. Table 2 shows the maximum and minimum values of Von Mises stress.

Table 2 : Minimum and maximum values of Von Mises Stress

Time [s]	Minimum [MPa]	Maximum [MPa]
1.	0.59743	56.775

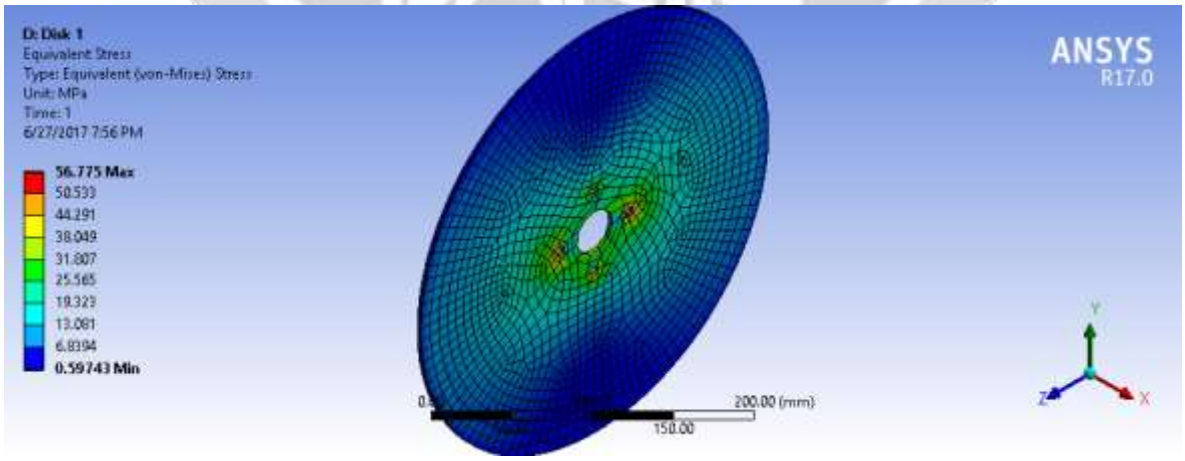

Fig. 7 : Von Mises stress

The maximum principal stress is calculated as shown in fig.8. The maximum principal stress is found on the pitch circle diameter holes. However it is moderate where the portion of disc is in the soil i.e. 50 % area of disc which is in soil have moderate principal stress values and other portion having minimum principal stress values. Table 3 shows the minimum and maximum values of principal stress in MPa.

Table 3 : Minimum and maximum values of Maximum Principal Stress

Time [s]	Minimum [MPa]	Maximum [MPa]
1.	-4.4543	53.369

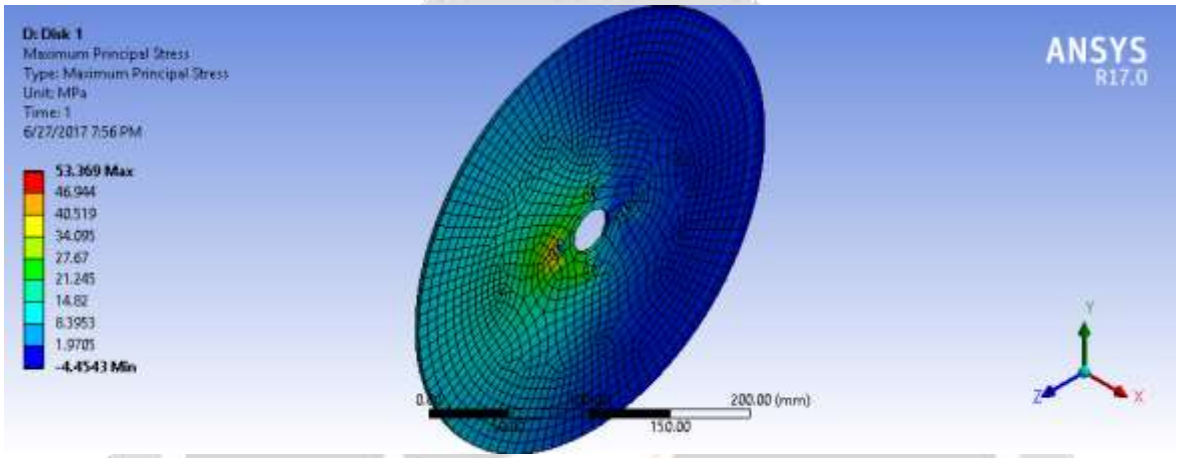

Fig. 8 : Maximum principal stress on furrow opening disc

The maximum shear stress is occurs in the middle portion where the holes are provided as shown in fig.9. It is maximum at the pitch circle diameter holes. Table 4 shows minimum and maximum values of maximum shear stress in MPa.

Table 4 : Maximum shear stress

Time [s]	Minimum [MPa]	Maximum [MPa]
1.	0.34386	31.016

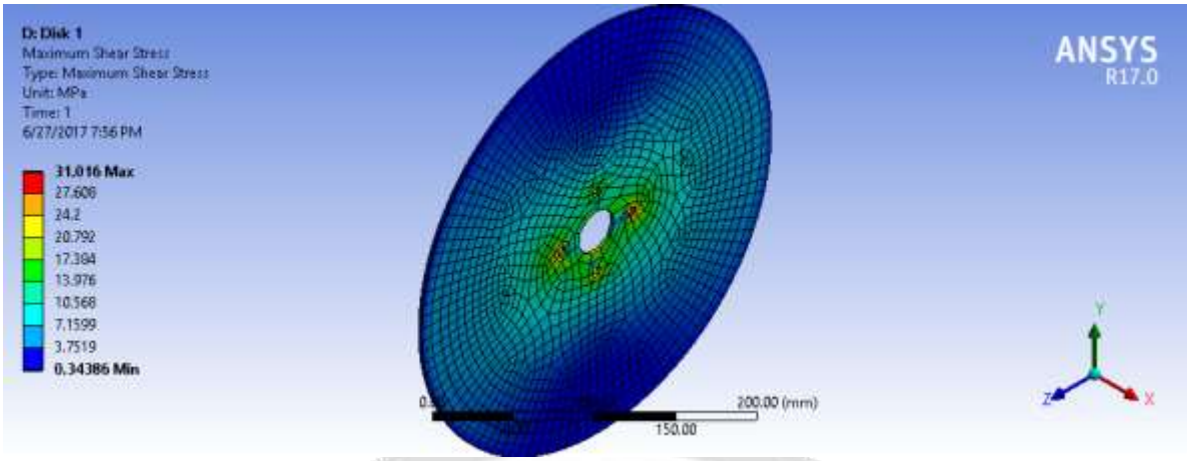

Fig. 9: Maximum shear stress

Fig. 10 shows maximum principal elastic strain which is very negligible. Table 5 shows the minimum and maximum values of maximum principal elastic strain.

Table 5 : Maximum principal elastic strain

Time [s]	Minimum [mm/mm]	Maximum [mm/mm]
1.	1.1791e-010	2.6334e-004

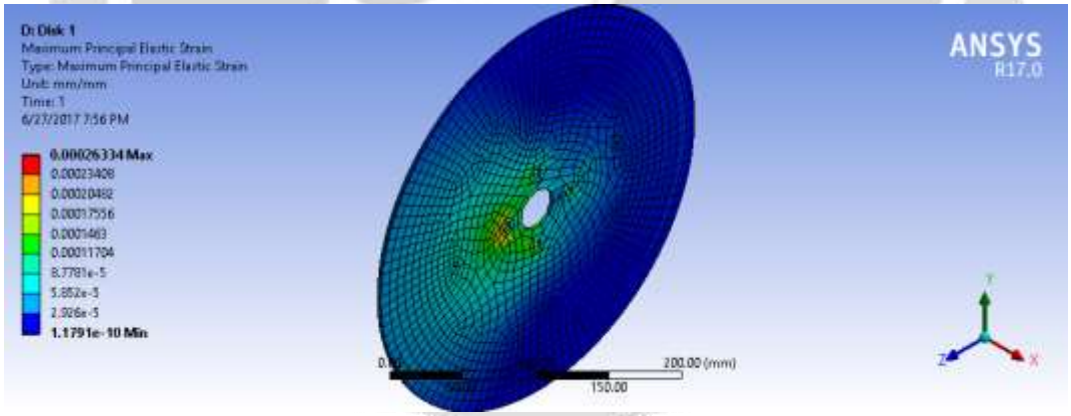

Fig. 10 : Maximum principal elastic strain

4. CONCLUSIONS

The maximum stress as well as deformation is found near the centre hole and on pitch circle diameter holes. Thus if the thickness of disc is increase at the middle portion rather than keeping the same thickness of disc, the stress as well as deformation can be reduced and life of part will be increase.

6. REFERENCES

[1]Ali Khosravani Goshtasb, Jack Desbiolles1 and John Fielke,(2014) Circular Disc Blade Considerations in Soil Force Prediction Modelling, *Journal of Agricultural Science and Technology* pp 371-383

[2]E. Seidi, Effects of Geometry of Disk Openers on Seed Slot Properties,(2012) *World Academy of Science, Engineering and Technology. International Journal of Biological, Biomolecular, Agricultural, Food and Biotechnological Engineering* 12-20.

[3]Md. Monjurul Alam,(1989) Soil reaction forces on agricultural disc implements, *The University of NewcastIe*, 1, pp 62-68.

[4]E. Seidi, S.H. Abdollahpour, A. Javadi and M. Moghaddam,(2010) Effects of Novel Disk-type Furrow Opener Used in No-Tillage System on Micro Environment of Seed, *American Journal of Agricultural and Biological Sciences*, pp1-6.

[5]E.M. Tice, J.G. Hendrick,(1992) Disc coulter operating characteristics, *Transactions of the ASAE*, 3-10.